

NOT FOR PUBLICATION UNTIL RELEASED BY THE
SENATE ARMED SERVICES COMMITTEE
EMERGING THREATS AND
CAPABILITIES SUBCOMMITTEE

STATEMENT OF
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BEFORE THE
EMERGING THREATS AND CAPABILITIES SUBCOMMITTEE
OF THE
SENATE ARMED SERVICES COMMITTEE
ON
DEFENSE SCIENCE & TECHNOLOGY STRATEGY AND
THE FISCAL YEAR 2006 BUDGET REQUEST

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Mr. Chairman, distinguished members of the Subcommittee, thank you for this opportunity to appear before you to discuss the Department of the Navy's science & technology in support of the global war on terrorism, transformation, and beyond.

Overview

The Fiscal Year 2006 Budget requests \$1.78B for a Science & Technology (S&T) portfolio designed to provide the best scientific research and technology in the shortest time to maximize the benefit to our Sailors and Marines.

We pursue an integrated and comprehensive S&T program, from basic research through manufacturing technology. Programs emphasize integrating basic research with applied science and technology, promoting the effective and expeditious transition of discovery and invention into real-world applications. Moreover, "transition" has become of utmost importance, as the success of S&T is not measured simply by the basic science it supports, but also by the active and successful transition of that science to supporting America's Sailors and Marines in the field: discovery and invention as well as exploitation and deployment of advanced technologies for the nation's Naval warfighters.

Naval Science and Technology for the Global War on Terrorism

The Government should maintain a great research laboratory to develop guns, new explosives, and all the technique of military and naval progression without any vast expense.

Thomas Edison

You will remember that I came before this subcommittee a few years ago and brought a prototype for demonstration of the Dragon Eye, a small unmanned aerial vehicle (UAV), for small unit tactical reconnaissance. The Dragon Eye is small, light, easy to transport, and easy to fly. This UAV has transitioned into the Marine Corps Force and accompanied the First Marine Expeditionary Force (I MEF) in deployment to Iraq last year. I have pictures of your Marines using the Dragon Eye UAV in the battle of Fallujah.

In response to the decision to deploy I MEF to Operation Iraqi Freedom (OIF) II Secretary of the Navy, Gordon England established Operation Respond. It provided a forum and process to articulate urgent operational needs to the senior leadership. It facilitated the procurement of existing systems and rapid insertion of technologies to support our Marines and Sailors in combat.

Rapid Response to Emergent Operational Medical Problems

ONR is taking part in a series of medical initiatives to support both OIF and Operation Enduring Freedom (OEF). One such initiative is a USB Memory device, called the “thumb” drive, for storing medical records. An important problem faced by medical teams in OIF and OEF is the transportation of patients to higher levels of care without their medical records. This means the receiving caregivers are unaware of previous treatment, which results in delays or sub-optimal care. Attaching a “thumb” drive containing patient records to soldiers’ dog tags would minimize this problem. Over 1,000 USB “thumb” drives have been provided to I-MEF to be evaluated in-theater.

A second serious problem in OIF and OEF is that hypothermia resulting from blood loss causes metabolic acidosis and impairs coagulation in the wounded. Currently, casualties are transported in poncho liners or body bags, neither of which provides heat. In a second OIF/OEF Medical initiative, ONR has acquired newly FDA approved blankets which use chemical heating packs to prevent hypothermia. Currently, about 100 blankets are being sent to I-MEF for field evaluation.

Effectiveness and capability of current medical gear is a third area in which ONR is pursuing medical initiatives. The Naval Combat Trauma Registry has been implemented to capture injury data (type, cause, severity, anatomical location, frequency, DNBI, etc.). Data is obtained at Level II medical treatment facilities and above and will indicate medical capability gaps and effectiveness of current gear (e.g., eye protection).

A fourth problematic area of OIF/OEF is the recertification of reservist and corpsmen/medics. The current OPTEMPO requires the deployment of these forces, who may or may not be fully up to speed on combat medical procedures. The Tactical Combat Casualty Care

(TC3) Training CD has been developed to help solve this problem. The TC3 CD provides scenario-based medical training to improve first-responder care and encompasses Care Under Fire, Tactical Field Care and Casualty Evacuation Care.

Current body armor is designed to protect the torso, leaving the arms and legs exposed to serious injury from a blast. In order to reduce injuries to arms and legs caused by Improvised Explosive Devices (IEDs), another medical initiative is working to develop arm and leg protection equipment. Review of medical data for injury trend evaluation has been done and injury sites for which protection can be provided have been determined. Ballistic testing of proposed material systems has been completed and initial arm and leg protection designs have been completed and given to warfighters. Warfighter feedback has been incorporated and used to modify the original and second phases of the designs. Phase three of the design is currently undergoing evaluation to ensure the appropriate design, as well as lay-up of materials, to ensure warfighter wearability, mobility, and protection.

Counter IED Efforts

Under the leadership of the Secretary of the Navy, we have focused our efforts on countering IEDs, rocket propelled grenades, and mortars. I believe a key S&T goal in resolving the IED threat is to understand the basic phenomenologies involved in the ability to detect, defeat, and destroy IEDs at range and speed. Long term basic and applied research must be conducted to address the foundations of current and future IED problems. We must exploit our sensor, chemistry, physics, material, and electronic warfare expertise by taking a systems approach to attacking each step in the engagement sequence. When we are successful, this ability could effectively deter this line of attack.

The first step in achieving these goals is the detection of IEDs at standoff distance. This ability must be able to cover a wide range of threats, from generic to specific. It must also be adaptable to developing and changing threats. This requires significant S&T investment, and although there is no clear “Silver Bullet”, testing is underway to identify promising technologies. The second phase of this process is the defeat of these explosives at standoff distances. Ongoing testing and experimentation is being conducted to determine the possibilities for future methods to defeat of such threats. The third and final phase is IED destruction at a standoff distance.

Some current detonation and deflagration solutions require knowledge and location of IED threats in order to have the greatest destructive impact. These solutions have an adequate impact on the main charge of the IED, but only limited capabilities in the destruction of other components.

Taking into consideration Secretary England's guidance and the progress made thus far, we must continue this effort throughout the naval research enterprise, especially the Naval Research Lab and the University Affiliated Research Enterprise along with the other services, defense agencies and national science and research academies and foundations. Though a strong cornerstone currently exists, based on the previously outlined solutions, the focus must be shifted and an investment must be made on both the detection of IED threats and advanced long range destruction technologies. Concentration on detection, defeat, and destruction of IED threats, while maintaining the ability to adapt our technologies to developing and changing threats, will allow us to actively and aggressively pursue these initiatives.

Additionally, last April, a special Small Business Innovation Research (SBIR) effort was pushed forward to address three critical areas: technologies to defeat improvised explosive devices, anti-rocket propelled grenades technologies and anti-rocket, anti-artillery and anti-mortar technologies. We received 259 proposals and a total of 29 SBIR efforts were selected for Phase I funding. At this time we are evaluating promising Phase I efforts in order to select the Phase II recipients. Next year we will be evaluating the Phase II results.

Those are some of our highlights within this S&T budget request for the Global War on Terrorism. Naval science and technology is a sustained journey from discovery to deployment in which innovation and invention leads to experimentation and validation and transform the operating forces. This is a continuous cycle.

I would like to discuss our transformation efforts for the "Next Navy and Marine Corps" - roughly the forces that will emerge over the next five to fifteen years, and finally the "Navy and Marine Corps After Next"—which we will see in fifteen to thirty years.

Transformation: Future Naval Capabilities

A great deal of our transformational effort is lodged in Future Naval Capabilities (FNC). The objective of the FNCs is to provide enabling capabilities to fill identified gaps in Naval Power 21 warfighting and enterprise capabilities identified by the requirements analysis staff of the Chief of Naval Operations and the Commandant of the Marine Corps.

We have focused a major portion of our S&T portfolio on FNCs for the “Next Navy and Marine Corps.” Approximately two-thirds of our Advanced Technology Development (6.3) funds and about 40% of our late stage Exploratory Development (6.2) funds are invested in the FNCs. The FNC process delivers maturing technology to acquisition program managers for timely incorporation into platforms, weapons, sensors, and process improvements. Each of the current FNC focus areas is planned and reviewed by an integrated team with representation from the Office of Naval Research, a Program Executive Office (PEO), the Navy and Marine Corps requirements community, and the Fleet/Force user community. This gives us constant validation of the relevance of the technologies, and strong buy-in and commitment to transition plans.

Based on the reviews of the FNC Technical Oversight Group we have recently strengthened the alignment of the FNC process with the Naval capabilities development process, which establishes our program requirements and priorities in Sea Strike, Sea Shield, Sea Basing and FORCEnet.

The FNCs, in no priority order, are:

- **Advanced Capability Electric Systems** – The future of naval warfare is electric. Warships will have revolutionary power plants that permit new hull forms and propulsors, reduce manning, streamline logistics, power advanced sensors, and enable future high energy and speed-of-light weapons. This FNC crosses several of the pillars, including, *Sea Strike, Sea Shield, and Sea Basing*.
- **Autonomous Operations** – This program is pursuing a dramatic increase in the performance and affordability of Naval air, surface, ground, and underwater autonomous vehicles—unmanned systems able to operate with a minimum of human intervention and oversight.

The Autonomous Operations FNC gives us a great potential to operate effectively in what would otherwise be denied areas. It is now aligned to the ***ForceNet*** pillar.

- **Fleet/Force Protection** – We have very capable ships, aircraft, and ground combat vehicles. It's our business to ensure that they don't fall to the sorts of asymmetric threats our enemies pose. This FNC, aligned with ***Sea Shield***, is working to develop effective organic means of protection: weapons, sensors, countermeasures, stealth and damage control.
- **Knowledge Superiority and Assurance** – Information technology is as crucial to naval superiority as it is to any other aspect of contemporary life. This program is developing our ability to distribute integrated information in a dynamic network with high connectivity and interoperability. It will ensure knowledge superiority, common situational understanding, and increased speed of command. This FNC is a key enabler of ***FORCEnet***.
- **Littoral Anti Submarine Warfare** – This program is part of our shift in emphasis to littoral, expeditionary operations. The antisubmarine warfare challenge in coastal waters is a tough one so, we are focusing scientific efforts on enhancing our ability to detect, track, classify, and engage enemy submarines by using a layered tactical ASW approach. We do this by first countering enemy submarines near shore, followed by addressing threat submarines prior to their torpedo launch, and then countering any threat torpedoes after launch. Each layer by itself will effectively address its individual objective; and when the layers are viewed in their entirety, it offers an effective “system-of-systems” approach that we believe will adequately address the ASW problem. ***Sea Shield*** is benefiting from the enabling capabilities of this FNC.
- **Littoral Combat and Power Projection** - The enabling capabilities in this FNC are aligned to ***Sea Strike***. This FNC focuses on deploying uniquely capable combat and logistics systems necessary to deploy and sustain the Fleet and the Force without building up a large logistical infrastructure ashore.
- **Missile Defense** – This program is focused on technology enabling and supporting lethal engagements of theater missiles, manned and unmanned aircraft at extended ranges in defense of naval forces and assets afloat and ashore. Products being worked will offer ways

to expand the battlespace rapidly, identify contacts accurately, and engage threats effectively and efficiently. The Missile Defense FNC is aligned to the *Sea Shield* pillar of the Navy's Sea Power 21 operational concept.

- **Organic Mine Countermeasures** – Because they are cheap, and able to seed the battle space with a menace far out of proportion to their numbers, mines have been and will continue to be deployed against us by terrorists and their state sponsors. We're working to give our forces an organic—that is to say, an inherent—and stand-off ability to detect, characterize, and neutralize mines wherever they may be encountered. Aligned with *Sea Shield*, this FNC has transitioned several important products. One of them, the REMUS autonomous underwater vehicle, is now in the hands of our operating forces in Iraq where it helped clear the rivers to speed supplies to troops. REMUS emerged from a basic oceanographic research program—another piece of evidence that overnight successes are long in preparation.
- **Time Critical Strike** – We are substantially reducing the amount of time it takes to hit critical mobile targets, like theater ballistic missile launchers, command centers, and weapons of mass destruction. One of this FNC's products, the Affordable Weapon System, a loitering cruise-missile-like system that can carry a variety of payloads, transitioned to the acquisition community for development. Time Critical Strike is aligned with *Sea Strike*.
- **Total Ownership Cost** – This FNC uses advanced design and manufacturing processes to significantly decrease the cost of buying, operating, and maintaining Navy systems while promoting increased system readiness. We are working to reduce total lifecycle costs during design and manufacturing as well as increase savings realized from reduced manning and better environmental compliance. This FNC supports efforts across all the Sea Pillars.

The relatively mature technologies managed in FNCs do not spring up overnight. In many cases they are the result of long term investments in research and invention programs in basic research and early applied research funding categories. We focus our research and invention investments on areas where the Navy is the only significant U.S. sponsor, such as Ocean Acoustics and Underwater Weaponry, and on S&T Grand Challenges whose solution would provide significant advances in Naval capability, such as Naval Materials by Design.

A stable, long term discovery and invention investment is essential to keep our pipeline full of enabling technologies and to attract the nation's best scientific talent to focus on Naval problems.

Transformation Initiatives

In addition to the FNCs, there are several ongoing S&T initiatives that may provide game-changing capabilities. They include the Hi Fly hypersonic vehicle, superconducting electric drive motors, the Virtual At-Sea Training (VAST), and the Advance Multi-Function Radio Frequency Concept (AMRF-C).

The hypersonics flight demonstration program (HyFly), a National Aerospace Initiative, will seek to demonstrate a hypersonic vehicle with a sustainable cruise speed of Mach 6 and a range of 600 nautical miles. To obtain this performance, work is focusing on the Dual-Combustion Ramjet (DCR) concept invented by the Johns Hopkins University Applied Physics Laboratory. Unlike the pure supersonic combustion ramjet—or “scramjet”—which requires highly reactive fuels unacceptable in the naval environment, the DCR relies on conventional liquid hydrocarbon fuels.

The Secretary of the Navy and the Chief of Naval Operations are committed to making the electric ship our ship of the future and we are providing the science and technology. A key requirement for installing electric propulsion in a destroyer-sized combatant is a high-power electric motor. Although conventional induction motors can be scaled up to that power level, and there is similar promise in permanent-magnet synchronous motors, the phenomenon of superconductivity offers significant potential for smaller size, higher power density, and quieter running. At very low temperatures, approaching absolute zero, superconducting materials lose virtually all resistance to the flow of electric current, which means that extremely large currents can be carried in smaller wires without excessive heat dissipation. These large currents also generate much more powerful magnetic fields—and hence more electromotive force—in motor windings much smaller than their conventional counterparts. Thus, for the same power output, a superconducting motor can be as much as 70 percent smaller than its conventional equivalent, including the cooling system needed to maintain sufficiently low temperatures.

The Virtual At-Sea Training (VAST) system was first demonstrated in fleet exercises in November 2002 and will be incorporated into the Battle Force Tactical Training (BFTT) program. VAST superimposes a three-dimensional, virtual-reality battlespace on an area of the open ocean and enables ships' crews to conduct live-fire gunnery exercises against simulated land targets at sea. A sonobuoy field planted in the target area locates the fall of each round within the simulated battlespace, and its effect appears on a computer-generated display that shows how a real-world view of the area would appear to a forward observer. Simultaneously, other computer screens show the corresponding radar or visual pictures for fire-control plotters, gunners, and navigators. In the sense that its simulated battlespace can be modeled on actual targets of interest anywhere in the world, VAST provides even more realistic training than a fixed gunnery range ashore. Soon, these same virtual-reality techniques will be extended to support at-sea training for close air support, long-range strike missions by naval aircraft, and undersea warfare.

The growing number of shipboard radio-frequency (RF) functions that require topside antennas and apertures creates a serious challenge for the Navy, particularly when own-ship radar signatures must be so carefully controlled. The Advanced Multifunction RF Concept (AMRF-C) is focused on a proof-of-principle demonstration of broadband RF apertures capable of performing radar, electronic warfare, and communication functions simultaneously using common, low signature phased arrays. AMRF-C will divide the frequency band into an optimal number of bandwidth segments and use separate, electronically scanned, solid-state transmit and receive apertures in each portion. AMRF-C's initial demonstration will concentrate on the upper band and simultaneously accommodate low-probability-of-intercept navigation radar, satellite and data link communications, and electronic warfare functions, including electronic attack. An AMRF-C test bed that incorporates a prototype control and signal-processing architecture is already in operation, and promising transition opportunities have been identified.

Transformation – Innovative Naval Prototypes

The Fiscal Year 2006 Budget requests funding to develop several Innovative Naval Prototypes (INPs). These initiatives include:

- An electro-magnetic railgun prototype gun capable of launching precision-guided, hypersonic projectiles at supersonic speeds against targets with flight times measured in seconds and minutes, not hours.
- New concepts for persistent, netted, littoral anti-submarine warfare. Can we integrate multiple Unmanned Underwater Vehicles and other sensors, an associated underwater support infrastructure, into a comprehensive distributed surveillance system that would consist of a substantial number of independent, but mutually communicating, vehicles equipped with tactical or oceanographic sensors for continually searching a shared ocean volume. Cooperating units could dump collected data, replenish power sources, and update mission assignments. Virtually all of the sensor, propulsion, and docking technology needed to implement such a scheme is already in hand, but challenges remain in devising a reliable methodology for “autonomous collaboration” among the participants.
- Technologies to enable Seabasing - For example, ONR’s long-standing investment in naval architecture and marine engineering has supplied the technology—advanced hull types, composite materials, and new propulsion systems—that will enable the design and construction of 50-knot “connector” ships able to deliver 5,000-ton payloads from sea bases to objective areas some 3,000 miles away. Increasing containerization of military cargo and supplies requires corresponding new efficiencies in stowage and handling procedures as well as the ability to transfer containers among ships and to offload them onto lighters—at sea—in conditions up to Sea State 4.
- The tactical utilization of space. In direct response to a Defense Department transformational initiative to facilitate more timely exploitation of space by combatant commanders, NRL will soon launch the first in a series of experimental tactical micro-satellites denoted TACSAT-1. TACSAT-1’s concept of operations includes responsive, on-demand space lift, near-real-time

tasking by theater commanders, and dissemination of sensor data by means of SIPRNet protocols. TACSAT-1 will be launched into low earth orbit (LEO). The initial sensor package will include both a thermal imager and a visible light camera with modest, but tactically useful resolution. On orbit, TACSAT-1 will be available to regional combatant commanders for operational experiments intended both to evaluate this initial micro-satellite system and to provide real-world experience with the concept.

I am excited about the Innovative Naval Prototypes. These are the capabilities that promise to fundamentally change how we prepare for and fight wars. A more tangible example of this is the SEA FIGHTER (FSF-1), also known as X-Craft, that we launched in February of this year. The SEA FIGHTER is a high speed aluminum catamaran that will test a variety of technologies that will allow us to improve our capabilities in littoral, or near-shore, waters. The SEA FIGHTER FSF-1 will be used to evaluate the hydrodynamic performance, structural behavior, mission flexibility, and propulsion system efficiency of high speed vessels. The SEA FIGHTER will be the first Navy purpose built ship to demonstrate mission flexibility. Mission flexibility will be demonstrated through interchangeable “mission modules” housed in the SEA FIGHTER’s large Mission Bay in standard twenty-foot container boxes. The Mission Bay will be capable of housing twelve containers, permitting the vessel to be quickly reconfigured to support a variety of potential missions, including battle force protection, mine counter-measures, amphibious assault support and humanitarian support. A multi-purpose Stern Ramp will allow SEA FIGHTER to launch and recover manned and unmanned surface and sub-surface vehicles up to the size of an 11 m Rigid-Hull Inflatable Boat (RHIB). From its flight deck, SEA FIGHTER FSF-1 will be able to support 24-hour a day operations for up to two MH-60S helicopters. When turned over to the fleet in May 2005, SEA FIGHTER, manned by a joint Navy-Coast Guard crew of two dozen will serve as a risk reduction “surrogate” for Littoral Combat Ship (LCS) concept of operations and technical capabilities development.

And Beyond - the Navy and Marine Corps After Next

At the basic research end of the spectrum, ONR-funded investigations are administered in accordance with scientific and technical disciplines—ocean sciences, materials, electronics, mathematics, physics, chemistry, medicine, and others—and their focus is on discovering and

understanding new phenomena that hold promise for future application in the Navy/Marine Corps-after-Next. Our research investment priorities focus on areas that are uniquely naval and maritime and usually of interest primarily to the sea services and areas where we leverage applicable naval disciplines in conjunction with the rest of America's basic research establishment.

We integrate the Naval Research Lab (NRL) and Office of Naval Research programs to maintain a strong corporate lab at NRL. Thanks to Thomas Edison's vision NRL has a long history at the forefront of basic research, including radar, nuclear propulsion, advances in time-keeping for the Global Positioning System, development of satellites, electronic warfare and today's GWOT "tools" to name a few.

A portion of our applied research (6.2) investment plans are targeted to the harvest of successful basic research concepts and knowledge for use in the Future Naval Capabilities, the Innovative Naval Prototypes, experimentation and other transitions. We are working to reduce the transition time of the fruits of the discovery and invention to less than ten years. We also work closely with the other services through the Department of Defense Reliance process to help rationalize the DoD wide S&T portfolio.

National Naval Responsibilities shape these basic and early-applied research portfolios, and ONR has earmarked a significant portion of its resources to sustain a critical mass of research and development efforts in these areas. These scientific and engineering disciplines—ocean acoustics, underwater weapons, and naval engineering—are critical for naval missions but are of limited interest to commercial industry and thus unlikely to attract significant private-sector investment. It is vital to keep such fields healthy, not only for the sake of our own capabilities, but to avoid technological surprise as well.

The Naval Science and Technology **Grand Challenges** are large, difficult, challenges that, if met, could give us decisive capabilities fifteen to thirty years in the future. We encourage the nation's scientific community to achieve breakthroughs in difficult but achievable scientific challenges like Naval Battlespace Awareness, Advanced Electrical Power Sources for the Navy

and Marine Corps, Naval Materials by Design, and Multifunctional Electronics for Intelligent Naval Sensors.

In conclusion, the nation's return on investment is clear. Success in the global war on terrorism, naval transformation and Navy and Marine Corps after next, depends on a balanced, long-term, stable and sustained investment in science and technology, validated through a cycle of on-going experimentation so we can transition new capability to the warfighter.

Thank you for the opportunity to testify.